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NOTES FROM PACIFIC COAST OBSERVATORIES

THE NUMBER OF THE SPIRAL NEBULAE

The probable total number of the spiral nebulae is a matter of considerable importance in all theories bearing on the constitution of these objects and their place in the sidereal plan. Fewer than ten thousand nebulae were known prior to the introduction of photography. One of the first results deduced by Director Keeler from his program of nebular photography with the Crossley reflector was that there exist many thousand small, uncataloged nebulae, the great majority of which are undoubtedly spirals. He placed their number at 120,000, and regarded this estimate as a very conservative one, as it was made early in the course of his program, and before many regions had been photographed. Later, Perrine, on completing the Keeler program, concluded from a count of the small nebulae found on fifty-seven of the one hundred and four regions of that program, that at least 500,000 small nebulae were within reach of the Crossley reflector, and deemed it not improbable that the total might ultimately exceed one million. The work was taken up again by Fath at Mt. Wilson, who found 1031 nebulae on 139 plates taken at the centers of the Kapteyn areas, and estimated that the number accessible with 60-inch reflector in exposures of one hour on Lumière Sigma plates would be 162,000.

The extent of the existing photographic material now makes possible a new determination of the number of the spiral nebulae. Descriptions of 762 nebulae and clusters are being published in a University of California semi-centennial volume; this list covers all work in this field with the Crossley reflector from 1898, when systematic work was commenced with this instrument at Mt. Hamilton, till February 1, 1918. I have counted the small nebulae on all regions of this program available for the purpose, finding 5698 small nebulae in 439 separate regions. To this must be added the 513 spirals included in the list, making the total number 6211.

The exposed area of a Crossley plate is about 0.9 of a square degree; the edges and corners of this area are, however, so poorly defined, owing to the distance from the optical axis, that only the brighter of the small nebulae can be picked up in these portions of the plate. The greater proportion are found in the more central portions having an area of 0.6 of a square degree, or less. I have assumed 0.75 of a square degree as the average effective area on which the counts were made; this is certainly somewhat in excess, but is an error on the conservative side. The regions are quite evenly distributed over the sky north of 30° south declination. If we divide the celestial sphere into two equal areas, one consisting of a zone 60° wide extending for 30° on each side of the galactic plane, and the other comprising the two zones of 60° radius about the two galactic poles, we shall find that 217 regions, or 49.4%, are located in the first, or galactic area, and 222 regions, or 50.6%, in the polar areas. The balance in the distribution of the regions in the galactic and extra-galactic regions is, then, nearly perfect.

On the other hand, bearing in mind the well-known concentration of the spiral nebulae in the vicinity of the north galactic pole, and the fact that this program deals primarily with regions containing known spirals, it is necessary to take into account, by subdividing the available material, any effect which a concentration of regions near the north galactic pole might have upon the resulting estimate. We may divide the celestial sphere into four areas, two of which will be the zones of 45° radius about the two galactic poles; a third area will comprise the two zones, each 15° in width, extending from −30° to −45° and from +30° to +45° galactic latitude, and the fourth area will be the zone 60° wide extending from −30° to +30° galactic latitude. The results are indicated in the following short table:

Galactic Latitude	No. Regions	Sq. Deg.	No. Spirals	No. per Sq. Deg.	No. in Area
+45° to +90°	117	88.50	2997	34	205,000
−45° to −90°	43	32.25	918	28	169,000
±30° to ±45°	62	46.50	1117	24	204,000
−30° to +30°	217	162.75	1179	7	144,000
Totals......	439		6211		722,000

It will be seen from the above that there is a concentration of the smaller spirals in the vicinity of the north galactic pole similar to that which obtains among the larger, visually discovered spirals, and that the density about the south galactic pole is somewhat less marked. The data given in the third line of the table are of special interest, showing that the small spirals persist to a distance of at least 60° from the galactic poles, with only a slight diminution of the degree of frequency which obtains in the polar areas.

The greatest number found on a single plate was 304 (checked by duplicate plate) in the remarkable region at $12^h\ 55^m$, $+28° 30'$; the region about N.G.C. 4826, less than 7° from this, shows only 2.

The only reason for reducing the estimate made from these counts would be the possibility that the small spirals may conceivably occur in greatest profusion in the regions contiguous to the larger members of the class, and evidence on this point is only to be secured by taking many additional plates at random.

In conclusion, I see no reason, at present existing, for changing the estimate made above, that at least 700,000 small spirals are within reach of large reflecting telescopes. Because of the fact that the faintest and smallest members of the class are, in general, discernible only in the more central regions of the plate, I am inclined to regard this figure as, if anything, an underestimate, and consider it very probable that the total number accessible may well exceed one million.

HEBER D. CURTIS.

A Spiral Nebula in the Milky Way

As is well known, the spiral nebulae show a tendency to group themselves about the poles of the Galaxy, apparently shunning the region of the Milky Way. A very few small nebula are found in regions near the Milky Way, and it has been possible to lay down the general rule that a spiral nebula is never found in the Milky Way structure itself. The nebula N. G. C. 6440 ($17^h\ 42^m.9$, $-20° 19'$), appears to form practically the only known exception to this rule.[1] Altho this object is some distance from the center of all the available Crossley plates of this region, rendering its details somewhat indistinct, there seems to be no doubt that it is a rather bright, nearly round, very compact, spiral nebula $1'.5$ in diameter. Its unusual interest lies in the fact that it is less than 2° from the galactic plane. It lies in the gap which separates the two branches of the Milky Way at this point, a region for which the spirals show their maximum degree of avoidance. As soon as this region comes within reach further plates will be taken with the nebula centrally placed.

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[1] Pease describes N. G. C. 6555 ($18^h2^m.7$, $+17°35'$) as "spiral in plan in Milky Way" (*An. Report Director Mt. Wilson Solar Observatory for 1916*, p. 244). This nebula is about 16° from the galactic plane.

Footnote.—In my absence from Lick Observatory Dr. Thiele took a plate of this object on April 10, with the object well centered on the plate. The conditions were poor, and it will take another plate to decide the question, but the probabilities are that it is a compact star-cluster showing evidences of spiral formation.